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Coronary thrombosis : a clinical study with case reports / by Claude T Mason

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CORONARY THROMBOSIS.

A CLINICAL STUDY WITH CASE REPORTS.

SENIOR THESIS.

by

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The syndrome of angina pectoris has been well known since the time of Heberden, but that of coronary thrombosis or cardiac infarction has been recognized as a definite entity only within the last two or three decades. Even in the latest text books, such as Osler's Principles and Practice of Medicine,(17) there seems to be confusion still existing in regard to angina pectoris and coronary occlusion. Osler's text still divides angina pectoris into three types: mildest, mild, and severe; and dismisses coronary thrombosis in less than one page. In his discussion of the first named condition he states that "the so-called status anginosus is usually due to coronary artery occlusion", but the clinical differentiation between the two conditions is scarcely mentioned and apparently not understood. Even such an authority as MacKenzie (13) apparently was not clear on this question. Most of the important contributions to our knowledge of the clinical picture of coronary thrombosis so far have been made by Americans and more recently by English investigators.

In this short study of cardiac infarction, I

wish to take up mainly the symptomatology and diagnosis. The pathology is of course included in the definition of the subject. The etiology of the condition is an unknown field, and I personally have been unable to even attempt to correlate my ideas or the ideas of various writers on the subject. The case histories I have been able to secure are quite lacking in etiological data, so I see no reason for attempting to write on a phase of the subject upon which I can draw no conclusions. The prognosis is another feature upon which I can make no accurate personal observations. An historical study does not appeal to me in the least, and I can see no particular value in it to the student.

PATHOLOGY. The pathology is the definition of the subject. Coronary artery thrombosis or occlusion and cardiac infarction are pathological terms and are practically self-explanatory. They stand in the relation of cause and effect to each other, myocardial infarction being the result of occlusion of a coronary artery or one of its branches. The most common cause of sudden occlusion is thrombosis. Embolism may at times be the cause, but apparently is rather rare. Arteriosclerotic closure of the coronaries is a gra-

dually developing, chronic affair, and though often associated with coronary thrombosis, is seldom in itself a cause of acute cardiac infarction. However, cases have been reported in which there was definite infarction found at autopsy, but no thrombosis, merely obliteration of the coronaries by sclerosis. Such cases, as a rule, do not give the definite clinical picture of acute occlusion, the process being gradual in development.

When a coronary artery or one of its branches is suddenly occluded, as by a thrombus, the myocardium supplied by that vessel is deprived of its blood supply. The changes which the myocardium then undergoes are described in any text book on pathology. Those listed by Delafield and Prudden (3) are: fatty degeneration or necrosis of muscle fibers, with sometimes considerable extravasation of blood, leading to rupture of the heart, or gradual absorption of the degenerated muscle tissue and replacement with fibrous tissue. Levine (11) gives a much more detailed description of the pathology with special emphasis placed on the time relationships of the various phases of infarction. In brief, his findings are: extravasation of blood and its accompanying features for the first three or

four days; necrosis of heart muscle from the beginning, but more marked and the "predominating feature" from the fourth day to the end of the third week"; "connective tissue replacement of damaged muscle... not a striking feature until after the third week"; and "more than five weeks required for cicatrization to develop adequately to prevent possible rupture".

Thrombosis may occur in any portion of the coronary system. However, certain branches are more prone to the development of thrombi than are others. There seems to be quite general agreement among writers on this subject that the anterior descending branch of the left coronary artery is the most frequent site for coronary thrombosis. This point is particularly striking in the cases analyzed by Levine (11). Whitten (25) more recently has made a special study of the localization of myocardial infarction and has found that the type of branching of the arteries supplying the right and left ventricles is entirely different. "The branches of the right coronary artery in the right ventricle spread out on the surface beneath the pericardium in a plane parallel with the surface of the heart", while those "of the left and right coronary arteries supplying the left

ventricle arise at right angles from the inferior surfaces of the main trunks and penetrate straight through the thickened myocardium". He maintains that "infarction is much more common in the left ventricle than in the right", and that "this is thought to be due to the perpendicular type of branching of the coronary arteries in the left ventricle". He also contends that "infarction of the posterior surface of the left ventricle is more frequent than has been recognized previously".

In addition to the myocardial pathology there is practically always associated pathology of the endocardium or pericardium or both. Levine (11) states that the "best evidence"of this is "mural thrombosis and pericarditis". He found that "mural thrombosis was much more common than pericarditis" and that in the cases in which "a thrombus was found in both the left and right ventricles.....the area of infarction involved the interventricular septum". Associated embolic phenomena also are not uncommon, the source of such emboli in most cases being the mural thrombus. Such secondary embolism may occur in any organ, "most frequently in the spleen, kidneys, brain, and lungs".

Cardiac enlargement is present in most cases of coronary occlusion. This finding is an evidence of long-standing cardiac disease, rather than of an acute process. Levine (11) raises the question as to "whether infarction ever occurs in a heart that is normal in size", saying that "however acute the onset, it must necessarily be an accident developing in the course of a chronic process". This feature of the condition is evidenced by the frequent association of coronary arteriosclerosis with resulting myocardial changes in cases of coronary thrombosis. General arteriosclerosis is also often present, but there may be no evidence of generalized arterial pathology. The coronary sclerosis may be very marked or very slight. In a fair proportion of cases there is no evident chronic coronary pathology.

SYMPTOMATOLOGY. The symptoms and signs of typical acute cardiac infarction are well described in practically every article on the subject, and should be familiar to all students and practitioners of medicine. Typically the clinical pict-ure is that of sudden onset of severe, constricting, or crushing, agonizing pain in the chest (usually substernal) or epigastrium; often referred to the left arm or both arms or to the

back; often following a meal or physical exertion, but in many cases unprovoked by any special effort. This is accompanied or quickly followed by a condition of profound shock with profuse cold clammy perspiration; a peculiar grayish pallor; possibly some cyanosis of the lips; dyspnea; vomiting in many cases; a weak thready pulse, somewhat increased in rate; fall in the blood pressure; pyrexia; and leucocytosis.

The patient stricken with a coronary thrombosis knows that something extremely serious has happened, and is in a state of fear of impending death. This fear is clearly expressed by the facies. In those instances in which the patient has suffered previous attacks of angina pectoris, he will generally describe the present attack as essentially similar but different in an indefinable way. The pain is similar in location and radiation, but is much more enduring and severe. It is not relieved by rest nor by the nitrites (nitroglycerine, amyl nitrite, etc.). It is relieved only by narcosis, preferably with large doses of morphine. Even this does not entirely relieve the pain in some cases, but it makes it bearable and the patient generally will go to sleep.

Though pain is the outstanding and characteristic

feature of typical coronary thrombosis, it may in some cases be only a minor symptom or even entirely absent. Herrick (8) lays special stress on atypical features such as the absence of pain, and states that "abrupt heart failure with its dyspnea and other phenomena" are the "substitution symptoms" (as expressed by Libman) or "pain equivalent" (as expressed by Obratzow and Straschesko). Adamson (1) gives the absence of pain as one of the characteristics of right coronary artery occlusion and the classical picture as characteristic of left coronary occlusion, but offers no pathological evidence. This theory does not seem tenable to me. Levine (11) had several painless cases in his series and only two of them were right coronary thrombosis. Herrick (8) offers the suggestion "that normally certain areas of the heart are not only less vital than others....but also less sensitive", and also that when "there has....been a very gradual and progressive narrowing of the artery by sclerotic processes,...the area irrigated by the artery has become relatively inactive, relatively anesthetized by destruction of vessels, nerves, and fuctioning muscles, so that a painful response to the new obstruction is lacking".

Next to the subjective symptom of pain and the appearance of the patient, the most charactistic features of coronary occlusion are the changes in the heart sounds, blood pressure, and electrocardiogram, and the pyrexia and leucocytosis. The heart sounds become weak, muffled, distant, or imperceptible. This is especially true of the first sound at the apex. Parsonnet and Hyman (18) have recently made a phonocardiographic study of this phenomenon, which they call "heart sound failure, hoping thereby to carry ... the concept of myocardial insufficiency or impairment translated into the terminology of the heart sounds themselves". They consider it "one of the pathognomonic signs of coronary thrombosis". In their phonocardiographic studies they found that the normal heart sounds gave a characteristic record, the first sound causing "a greater disturbance in wave transmission than the second", and the second sound "although of somewhat longer duration", being "characterized by vibrations of lesser amplitude". The heart sounds in coronary thrombosis, however, showed "a reversal of tonal configuration", the first losing amplitude and the second sound taking on the "normal

first sound characteristics", Both sounds also become somewhat prolonged. They state that "As the condition of the patient becomes progressively worse the heart sounds appear clinically to be shorter. Graphically, on the other hand, these sounds are revealed as being longer rather than shorter than in the normally functioning heart".

The blood pressure in coronary thrombosis typically falls to quite a low level. This is generally particularly marked in those cases that previously had hypertension. The fall in blood pressure may be almost immediate, or it may not occur for a day or so after the occlusion. In exceptional cases there may never be any noticeable lowering of the pressure. As a rule it remains low throughout the acute attack. After recovery it may still remain low or it may go up again as the myocardium regains strength. In cases where there was no previous hypertension or where the blood pressure was not known before the onset of the infarction, the determination of a lowered pressure is often difficult.

The development of fever and leucocytosis is not immediate as a rule, but generally occurs within the first twenty-four hours after the onset. The fever

is of the low grade type, usually about 100°F., occasionally as high as 102°F. According to Levine (11) the mouth temperature may be normal throughout the course of the acute infarction, but the rectal temperature will generally show an increase. The leucocyte count runs parallel with the pyrexia. It is generally definitely increased, but the leucocytosis is not especially high, in most instances ranging between 10,000 and 18,000. It may occasionally be practically normal, or there may be a much more marked leucocytosis, as high as 25,000 or higher. Both the pyrexia and the leucocytosis disappear as the infarction heals and the necrotic muscle tissue is replaced by fibrous tissue.

Rabinowitz, Shookhoff, and Douglas (20) have recently studied the red cell sedimentation time in coronary occlusion, a phase of the subject that no other investigators have touched on, as far as I know, They found that the sedimentation rate was rapid "in all cases", that it became "pathological later in the disease than the temperature and blood count", and that "it outlasted by an appreciable number of days the return of the temperature and blood count to normal". They suggest that "repeated determina-

tions of the sedimentation rate may aid materially in prognosis and treatment", and also that in diagnosis it "may be valuable in cases appearing for examination a number of days after an attack and presenting normal temperature and blood count".

Pericarditis occurring during the course of myocardial infarction has been referred to in the discussion of the pathology. This feature is demonstrable clinically by the development of a pericardial friction rub heard over the precordium on auscultation of the heart. This finding theoretically should be present in all cases with pericarditis. Actually it is not reported in many cases, probably because repeated careful examinations of the heart are not made. The absence of a friction rub is of no significance, but its presence is a sign of definite organic pathology in the pericardium and the adjacent myocardium.

Associated embolic phenomena in various more or less distant organs such as the lungs, liver, spleen, brain, and kidneys are evidences of mural thrombosis as a rule, and may occur at any time in those cases that develop thrombi within one or both ventricles. Such thrombi may of course be present and no secondary embolism ever occur. The incidence of mural thrombosis, as already noted, is probably greater

than that of pericarditis. There are no signs which can be elicited by examination of the heart to demonstrate their presence. The secondary manifestations are practically the only evidences of such pathology, and may be of graver import than the original condition, especially if the patient was recovering from the cardiac infarction.

Disturbances in the mechanism of the heart are naturally to be expected from the nature of the pathology of coronary thrombosis. Therefore, it is not surprising that there are frequent case reports in the current literature of infarctions with associated heart block (6,22) and various forms of arrhythmias. Levine (11) makes the statement that any of the various types of disturbances of rhythm of the heart beat may develop during the course of coronary thrombosis. Ventricular fibrillation is supposed to be the cause of death in many cases, especially in those that die within a short time after the onset, before it is reasonable to think that rupture of the heart has occurred. The development of such irregularities of the mechanism of the heart are sometimes demonstrable clinically, but often the aid of the electrocardiogram is needed to make a definite diagnosis of the type of disturbance

present. The presence of various types of bundle-branch blocks is of course not demonstrable execpt in the electrocardiogram. Such lesions may precede the infarction, being caused by coronary sclerosis, or they may develop secondary to the infarction. In either case they add to the gravity of the prognosis.

The electrocardiographic signs of coronary thrombosis have been quite extensively studied in recent years. The changes which develop in the electrocardiogram are not actually signs of coronary thrombosis, but are signs of myocardial damage. The electrocardiogram is merely a record of the conduction through the conduction system and musculature of the heart. The recent articles on this phase of coronary occlusion are too numerous to even mention in this short study. The conclusions in the articles I read were all essentially the same.(2,4,8,11,14,16,19,25,26) The "coronary T-wave of Pardee" is generally conceded to be the most frequent and typical sign of coronary thrombosis. This is an inverted T-wave and convex S-T interval which Pardee described in 1920 as developing during the course of coronary thrombosis. In addition there are often other changes in the electrocardiogram such as high or low take-off of the S-T interval from the Q-R-S

complex; prominent, diphasic, or isoelectric T-wave; large Q-wave in lead iii; minor changes in the Q-R-S complex; and marked fall in amplitude of the Q-R-S complex. The progressive nature of the changes recorded by the electrocardiogram is emphasized by Herrick (8) in the Harvey Lecture for 1931. He states:-"The electrocardiogram in these cases of acute myocardial destruction is not fixed;...for a long time it undergoes change.....The electrocardiogram, registering regressive and reparative processes, should and does show variations from day to day or month to month. The physician who gets his tracing right after the accident sees the prominent T-wave with the high take-off from R-wave. The one whose tracing is made a week or several weeks later stresses the altered, often inverted, T-wave, or the Pardee coronary wave, or some peculiarity of Q-R-S, perhaps its broadening or slurring." This feature has become well recognized and much of the later work has been in the form of serial studies of cases of coronary thrombosis over a more or less extended period of time. Cooksey and Freund (2) in such a study of twenty four cases reported that "positive electrocardiographic evidence" was "present in every case". A single record may be entirely negative, and therefore be practically valueless from a

diagnostic standpoint. Abnormalities which are not present early in the course of an infarction usually become evident days or weeks later.

The final outcome of coronary thrombosis is of interest from the standpoint of treatment and prognosis. Infarction of such a vital organ as the heart is an extremely grave condition. Considering the importance of the organ involved, the percentage of recoveries is somewhat surprising, in most series of cases about half recovering at least temporarily. Death may occur at any time during the course of the acute process. Immediate or early death is not uncommon and is probably due usually to disturbance of the mechanism of the heart beat with the development of ventricular fibrillation. Such a mechanism causing death is possible at any stage of the process. From the fourth day to the end of the fifth week the most logical explanation of the mechanism of death is rupture of the heart at the area of infarction. Secondary embolism to other organs from mural thrombi may occur at any time and be a cause of death. After this period recovery is probably the rule. The convalescence is quite slow, and an extended period of rest is required to allow the heart to recover its

strength. The heart may apparently return to normal after recovery; or it may show evidence of rather extensive myocardial damage, such as weakness and dyspnea on exertion that could formerly be done without difficulty, or edema of the ankles. The patient may later succumb to another attack of coronary thrombosis; or he may develop cardiac decompensation because of the damaged myocardium and make an exitus in that manner; or he may be entirely free from cardiac trouble for the rest of his life and die of some unrelated condition. Those patients who have had angina pectoris preceding the infarction may be partially or entirely relieved of their angina after it; or on the other hand, the attack of thrombosis may initiate an anginal state, the patient being subject to attacks of angina pectoris for the rest of his life following recovery from the infarction.

DIAGNOSIS. The diagnosis of coronary thrombosis should not be difficult in the typical case with severe substernal or epigastric pain, profound shock, low blood pressure, pyrexia, and leucocytosis. The difficulties in diagnosis are encountered in the atypical cases. The frequency with which coronary thrombosis is preceded by an anginal state for a period of months or years is often a great aid in directing the examiner's attention in the right direction.

In the differential diagnosis, angina pectoris is, of course, the primary condition to be considered. A correct differentiation between these two conditions, which are so closely related in symptomatology but not in pathology, is important; the treatment and prognosis being different. Some investigators have attempted to differentiate on the character and location of the pain. Graves (5) gives a chart on the differential diagnosis in which he gives the characteristics of the pain of coronary thrombosis as "epigastric, localized, without effort, hours, penetrating, day or night"; while those of angina pectoris are "substernal, radiates, with effort, minutes, constrictive, day then night". This method of differentiation does not appeal to me. I have seen attacks of undoubted angina pectoris in which the pain was almost entirely epigastric and there was no radiation, and I have also seen a case of coronary thrombosis in which the pain was mainly substernal and radiated to both arms. Douglas Hubble (9) in discussing this subject says: "The distinction between the pain of simple angina pectoris and of coronary thrombosis is solely one of degree, and in essential characteristics the pain of the two conditions is identical."

The pain of angina pectoris may in some cases be as severe and agonizing while it lasts as that of coronary thrombosis; and as previously noted, pain may occasionally be only moderate or entirely lacking in coronary thrombosis. There are all gradations in the severity of pain in both conditions. Therefore, it seems more rational to me to use as differential points the duration of the pain and the reaction to nitrites, rather than its location, severity, and radiation. All authorities are agreed that the pain of angina pectoris is relieved by nitrites, such as amyl nitrite and nitroglycerine (glonoin), while that of coronary thrombosis is not relieved by anything except narcosis. Hubble (9) gives as differential points of coronary thrombosis from simple angina pectoris "the duration of the attack, the collapse, the pyrexia, the fall of blood pressure, the nausea and anorexia, and the signs of congestive heart failure in the lungs and liver". In addition to these I would include the development of "heart sound failure", leucocytosis, rapid red cell sedimentation time, and electrocardiographic changes. In angina pectoris a normal electrocardiogram is relative common, while in cardiac infarction the record is usually abnormal at some time during the course of the disease.

Hubble (9) also emphasizes the differentiation of simple angina pectoris from what he calls "prodromal anginal attacks" which are "the prelude to cardiac infarction". He states that these prodromal attacks "unlike typical angina...may come on independently of effort or emotion and are not relieved in a short time by absolute rest....In hours or days they return with increased frequency and greater in severity until they merge into a prolonged anginal state which culminates in typical cardiac infarction. The whole process may occupy days or weeks". The reaction to nitrites in these cases he considers typical. It is different from that in either simple angina pectoris or infarction. The nitrite relieves the pain "for the period of its pharmacological action", but when the effect of the drug wears off the pain returns "with the same or greater intensity". He contends that "this reaction to nitrites, if proved to be constant, will be enough of itself to give warning of threatening thrombosis".

The importance of vagus pressure with marked slowing of the heart rate and sometimes actual stopping of the heart as a sign of acute cardiac infarction or myocardial damage of more chronic nature is mentioned by various authors. Herrick (8) believes

that "the test is of some value".as a diagnostic measure in suspected coronary disease. He comes to this conclusion because of "its almost uniform absence in those whose coronaries are and heart, presumably healthy--the young and cardioneurotic individuals; Its increasing frequency in the senescent, aged, and arteriosclerotic; the sometimes startling cessation of the heart beat in patients whose coronaries have recently been occluded, or in those whose hearts are inefficient supposedly from myofibrosis".

In addition to angina pectoris other cardiac conditions must be considered as possible causes of pain. Myocardial insufficiency, aortic disease, valvular disease, and pericarditis are all possibilities. In all these conditions, however, the history of onset and development generally is not especially suggestive of coronary thrombosis; the pain is not so definite in character, location, and distribution; there is generally no history of previous angina pectoris; blood pressure changes are not characteristic; and electrocardiographic evidence of infarction is lacking as a rule. Myocardial insufficiency on the basis of chronic coronary sclerosis gives many of the signs of thrombosis such as weak heart sounds, low blood pressure, and electrocardiographic evidence of

myocardial damage. As already noted, coronary thrombosis is very apt to occur in such a heart. Infarction in these cases is often very diffucult to diagnose because it develops during the course of gradually developing cardiac decompensation and often no acute episode marks the complete closure of a coronary artery.

Other conditions in the thorax which must be differentiated from cardiac infarction are pneumonia, pulmonary infarction, pleurisy, pneumothorax, and mediastinal pathology. In these cases X-ray examination tf the chest would be of definite aid, changes in the heart mechanism and heart sounds would be rare, and not characteristic, and the location and character of the pain would be different. Occasionally in pneumonia, as noted by Levine (11), changes occur in the electrocardiogram which are similar to those due to a cardiac infarction. This is rare, however, and with definite evidence of pneumonia can probably be disregarded, though I can see no reason why a patient with cardiac infarction cannot also have pneumonia.

As noted several times before, quite a large proportion of cases of coronary thrombosis have abdominal symptoms either entirely or along with the thoracic

symptoms. Such cases may start with sudden acute epigastric or generalized abdominal pain, nausea, vomiting, anorexia, etc., and develop abdominal tenderness and rigidity. The simulation of acute surgical conditions of the abdomen is thus perfect. An accurate differentiation is essential, since a case of coronary thrombosis certainly should not be subjected to the trauma of a major operation. Operations on such cases have been performed, usually with fatal results. The abdominal conditions to be considered are perforation of a viscus, most commonly of the stomach or duodenum from pectic ulcer, acute gall bladder disease with or without cholelithiasis, acute pancreatitis, acute subdiaphragmatic lesions, and acute appendicitis. MacKenzie (13) emphasises especially the differentiation of angina pectoris from gall-stone colic, and this applies as much to coronary thrombosis as it does to angina pectoris. Gastric crisis of tabes is also a possibility in addition to the surgical abdominal conditions. In all these cases of cardiac infarction with abdominal symptoms the history of previous anginal attacks in many instances, the changes in the heart sounds, the fall in blood pressure, the dyspnea, and the electrocardiographic findings should lead one to the correct diagnosis.

The difficulties in diagnosis are encountered mainly in the cases that are atypical in some way, such as the mild, painless, or entirely abdominal cases, or those in which no previous history is known. It is probably the wise course to at least rule out the heart in all obscure conditions of this nature in patients of middle age or older, especially when there is arteriosclerosis or hypertension preceding the onset.

CASE REPORTS.

Case I. G.A., white, male, 65 years old. First entered University of Nebraska Dispensary Jan.22,1927 with complaint of nine months duration of dull, aching pain beginning at base of neck and then over precordium, which radiated to shoulder and down left arm, and which appeared upon exertion. At that time: P95; B.P. 170/109; heart slightly enlarged to the left; F.H. and P.H. essentially negative; W.B.C. 13,800 with 79% polys; urine-trace of albumin. Diagnosis of angina pectoris made, and nitroglycerine and amyl nitrite advised. Amyl nitrite made him sick. Nitroglycerine gave some relief. B.P. taken several times in Jan.1927 ranged between 170/109 and 220/130. E.K.G. ordered but no report contained in the records. Next

entered U. of N. Dispensary again Feb.10,1932 with history of repeated attacks of dyspnea, and sense of compression and pain in chest over precordial region radiating to epigastrium and down inner side of both arms. Not relieved by medicines, but relieved some by heat over chest. Attacks at intervals of about two weeks. At this time; apex of heart outside nipple line in 5th i.c.s.; A2 accentuated; heart fibrillating; weight 190#; T.99; P.80; and B.P. 185/110. Diagnosis of angina pectoris and coronary occlusion on the verge of decompensation. Ophthalmoscopic examination-arteriosclerotic retinitis. Feb.13 placed on digitalis min. 60 the first day and then min. 30 b.i.d. Urine-examined several times-showed constantly small amount of albumin. Feb. 19 had pain in left arm all morning, Cramping pains over precordium began in afternoon and lasted 2½ hours, referred up neck and down both arms; followed by dyspnea, pallor, sweating, prostration, and some signs of decompensation (edema of ankles). Next day: B.P. 160/126. Diagnosis of coronary thrombosis made. Placed on the outcall service from which he was dismissed Feb. 24 because would no longer cooperate and insisted on leaving town. While on outcall service: heart fairly regular; heart sounds distant and hard to hear; no murmurs; P. 64 to 72; T. 98.4 to 99.6; W.B.C. not

made. Had an attack of vomiting on Feb. 21. E.K.G. taken Feb. 11 showed (1) auricular fibrillation, (2) left ventricular preponderance, and (3) marked coronary pathology--low take-off of S-T interval in leads i and ii and high take-off in leadiii.

In this case quite a complete record was available since he was seen at the U. of N. Dispensary shortly after the onset of his angina pectoris and also at the onset of the attack of coronary thrombosis. The infarction was accompanied by signs of cardiac failure, auricular fibrillation, and pyrexia up to 99.6 by mouth. Hypertension and arteriosclerosis had been present for at least six years, and angina pectoris (initiated probably by an attack of coronary thrombosis in 1927, when there was a definite leucocytosis and pain was not well relieved by nitrit) had been present for almost six years preceding the infarction. The pain in the last attack was referred to the epigastrium and to both arms, while in the previous anginal attacks it had generally been referred only to the left arm. It was described by the patient as being more severe and indefinably different from any of the previous attacks. Unfortunately leucocyte counts and additional blood pressure determinations were not made during the course of the infarction. The diagnosis was easily made from the history of previous angina pectoris, the quite typical clinical picture, and the electrocardiographic

findings. The treatment was very unsatisfactory, the patient refusing to cooperate. He was not much improved, even though out of bed, at the time of dismissal, still having signs of decompensation and a slight fever. The prognosis in this case probably is not good. According to White and Bland (24) an adequate amount of rest in bed is essential to a good prognosis; and they further state that "the presence of congestive failure and poor heart sounds adds considerably to the gravity of the prognosis".

Case II. G.H.W., white, male, 56 years old. History of six or seven years duration of repeated attacks of fainting, and substernal and epigastric pain sometimes with vomiting, relieved by rest, and usually coming on in the evening after a heavy day at work and a heavy meal. Always considered by patient and family to be attacks of "acute indigestion". Dec. 15, 1931 after a hearty evening meal, had another attack of "acute indigestion" with severe epigastric and substernal pain, vomiting, dyspnea, pallor, and sweating. Nitroglycerine and amyl nitrite used with only slight relief. Morphine gr. ½ gave relief. At this time: apex of heart in 6th i.c.s., anterior axillary line; heart sounds quite clear; no murmurs;

B.P. 180/94; no signs of decompensation. Seen at this time by Dr. C.W.Mason.. Diagnosis of coronary thrombosis made. From Dec. 15 till his death on Dec. 31, 1931 the patient was never free of pain and had pallor and orthopnea continuously. Large doses of morphine used to secure relief. Dec.30 seen by Dr. E.L.Bridges in consultation. At that time: B.P. 80/40; apex in mid-axillary line; heart sounds muffled; and pallor somewhat cyanotic. Died on Dec.31, 1931 in a fit of anger. Mouth temperature normal throughout final illness. Blood c count and E.K.G. not taken. Autopsy not performed.

The records in this case are incomplete from the laboratory standpoint because, as is so often true, there is no need to put the patient and family to additional expense when the diagnosis and prognosis are obvious from the clinical findings. The diagnostic points are the substernal as well as epigastric pain, the extreme prostration, sweating, dyspnea, low blood pressure, muffled heart sounds, and history of previous attacks of "acute indigestion". This brings home the fact that most cases of so-called "acute indigestion" are in reality angina pectoris or coronary thrombosis with abdominal symptoms. This case might also have been mistaken for

an acute abdomen. The definite cardiac signs of weak heart sounds, low blood pressure, etc,. were not present at the onset, but dyspnea and substernal pain were. The mouth temperature was normal, but the rectal temperature may have been increased as maintained by Levine (11). The cause of death was not proven by autopsy, but most probably was rupture of the heart at the area of infarction.

Case III. J.H.S., white, male, 49 years old. A traveling man who smoked, drank, exercised in excess, ate heavily, and was high strung. Occasional anginal attacks for about two years, usually brought on by mental or physical stress or overindulgence in food and drink. Pain referred to right arm as often as to left. In early part of 1931 following card party and excess of food and drink, had an attack of vice-like pain in chest and epigastrium and vomiting. Dr. L.T.Hall called and made diagnosis of coronary thrombosis, Morphine gr.½ given with no relief. Died in about 15 or 20 minutes. Autopsy performed and disclosed a large infarction of the heart and thrombosis of a large branch of a coronary artery.

This case again is illustrative of the type that is so often called "acute indigestion". It also is

an excellent example of the cases that die within a few minutes after the thrombosis. The extensive nature of the infarction probably was the cause of immediate death, the heart not being able to recover from the overwhelming effects of such a large lesion.

Case IV. W.H., white, male, farmer, 60 years old. In Dec. 1930 tried to take out life insurance and was told he had high blood pressure. In the late summer and fall of 1931 began having dyspnea which was diagnosed as asthma. In Oct, 1931 dyspnea became more severe and orthopnea developed and he became much weaker. In Dec. 1931 pain in epigastrium developed which was worse at mealtimes and was present a few minutes after eating. In Jan. 1932 had a very severe attack with dyspnea, pain in epigastrium, and chest, and edema of feet and ankles, and weakness. Weight loss of 20 lbs. in 3 months. Referred to the University Hospital with tentative diagnosis of ((1) Decompensation of the heart, (2) Cardiovascular disease, and (3) Probable carcinoma of the stomach. On admission to the University Hospital Jan. 23,1932: heart enlarged outside nipple; rhythm regular; no murmurs; B.P. 230/130; slight rigidity in epigastrium; and slight edema of ankles. Admission diagnosis was (1) Primary essential hypertension, (2) Secondary nephritis-sclerosis, (3) Cardiac decompensa-

tion, and (4) Possible gastric ulcer. During stay in hospital: W.B.C. 9,400 to 9,950 with 76% polys; urine showed 1+-albumin and occasional hyaline and granular casts; T., P., and R.,normal; blood chemistry normal; and Wassermann negative; X-ray studies demonstrated cardiac enlargement with left ventricular hypertrophy, normal gall bladder function, and normal stomach and duodenum; E.K.G. on Feb.3,1932 showed definite coronary pathology--low take-off of T-wave in leads i and ii, and also very short P-R interval suggesting nodal rhythm. Dismissed from hospital Feb.6,1932, condition improved.

This is an atypical case in which in my opinion the correct diagnosis probably was not made. The history of previous hypertension and the development of first dyspnea and later epigastric and thoracic pain, with also slight edema of the extremities, is much more suggestive of a cardiac condition than of any gastric condition, either malignant or otherwise. This opinion is confirmed by the normal gastrointestinal and gall bladder X-rays and the definite evidence of cardiac pathology on physical examination, X-ray, and electrocardiographic study. The underlying pathology in this case was probably a coronary thrombosis

on top of marked coronary sclerosis and chronic myocardial damage. This chronic condition would account for the atypical nature of the symptoms in which the pain was apparently subordinate to the dyspnea and weakness. He was not admitted to the hospital until late in the course of the infarction, if such it was, and therefore, the signs of infarction were not in evidence, such as fever, leucocytosis, heart sound failure, and low blood pressure.

Case V. W.K., White, male, farmer, 67 years old. Apparently well until Oct. 1931. Then while walking, carrying pails of milk, noticed sharp pains in muscles of both upper arms, was short of breath, and had to rest for a few moments. Had many such attacks 1 or 2 times daily until Xmas, when his doctor put him to bed and gave him digitalis. Weakness developed insidiously and was progressive. Dyspnea became marked, but no orthopnea. Moderate edema of ankles and legs developed in Jan. 1932. Entered the University Hospital Feb.16,1932, at which time : some emaciation; dyspnea; edema of legs and sacrum; congestion at bases of lungs; heart apparently normal in size and position; second sounds accentuated; heart sounds regular and weak; left pulse weaker than right; and B.P. 148/120. Admission diagnosis (1) Failing hypertension and (2) Myocardial decompensation. During

course in hospital: urine--albumin 1/ and occasional casts and pus cells; W.B.C. 10,000 to 13,000 with 88% polys; T. slightly subnormal most of time, extremes being 96.4 and 99.4 F.; P. and R. rapid most of time; Wassermann negative. At times complained of pain in chest, but no medication required to relieve it. E.K.G. of Feb.23,1932 showed changes considered indicative of coronary pathology and bad prognosis--inverted T-wave in lead i and S-T take-off slightly below base line in lead ii with a diphasic effect of T-wave. Died on Feb.24,1932. No autopsy. Final diagnosis (1) Arteriosclerosis and (2) Fibrosis of the myocardium.

This case is also atypical and a diagnosis of coronary thrombosis probably is not justified. However, it must certainly be included among the possibilities. The rather sudden onset with pain in the arms, dyspnea, and weakness is rather suggestive of an acute lesion at that time. It is justifiable to assume in view of the progress of the case that the coronaries were probably markedly sclerosed, and it is not at all impossible that actual occlusion occurred. The weak heart sounds, rather low blood pressure (systolic), leucocytosis, and electrocardiographic changes all are suggestive, but not conclusive evidence of

occlusion. They can all occur with marked coronary sclerosis and myofibrosis without complete occlusion.

Case VI. H.H., White, male, 53 years old. Entered the University Hospital June 25,1931 with cardiac symptoms and collapse, cough, dyspnea, and weakness. History of attacks of precordial pain since 1930. Admission diagnosis-myocardial degeneration. At that time heart regular in rhythm and rate, no murmurs or thrills. By July 8,1931: gallop rhythm; heart sounds faint but regular; B.P. 110/60; and fluid in left pleural cavity. Morphine gr.$\frac{1}{4}$ or $\frac{1}{6}$ given every night. Also on digitalis. Chest tapped July 17 and 135 cc. pale reddish fluid removed with relief . Auricular fibrillation developed at this time. July 21 developed severe attack, precipitated by climbing on a bed pan, of pain in l.u.q. of abdomen, rigors, and profuse cold clammy perspiration. Nitroglycerine gr.$\frac{1}{100}$ gave but slight relief. Morphine gr. $\frac{1}{4}$ gave only partial relief. Respirations became rapid (about 60) and shallow, No sounds heard over precordium. Pulse non-palpable. Caffein sodium benzoate gr. VIIss given with no response. Adrenalin 1 cc. injected intracardially with 4 or 5 strong pulsations following. Died at 5 A.M. July 22,1931. The interne made a note that the final attack was

suggestive of a new coronary infarct or a splenic infarct with perittoneal involvement. During course in hospital: urine--albumin 1 to 3+, bile 2+, few pus cells, occasional red cells, and many hyaline and granular casts; W.B.C. 11,000 to 25,000 with 85 to 91% polys; Wassermann negative; Blood cultures negative; E.K.G. on July 6,1931 showed evidence of coronary pathology and right bundle branch block--prolonged P-R and R-S intervals, R-wave in leads i and ii swinging directly into and inverted T-wave, and R-wave in lead iii slurred, notched, and inverted and swinging directly into an upwardly directed T-wave. Autopsy findings: (1) Aortic stenosis, (2) Arterio-sclerosis of coronary and adrenal arteries, and (3) Chronic passive congestion of lungs. Heart hypertrophied; weight 650 grams; several patches of scarring in ventricular wall especially on anterior surface of heart; atheromatous changes in both coronary arteries, one or two points being quite marked almost obliterating the artery.

This case is another atypical one.. The symptoms are mainly those of cardiac decompensation on the basis of long-standing myocardial damage from extensive coronary sclerosis. There was no definite thrombosis or recent infarction, though the symptoms of the final attack were surely suggestive. The areas

of scarring in the ventricular wall are in all probability evidence of previous infarctions. However, no history was secured as to the occurence of any such acute accidents, The scarring of the myocardium may, I presume, be entirely the result of the chronic coronary sclerosis, without thrombosis ever having occurred. It is in just this type of a heart, however, that thrombosis and infarction often develops unrecognized because the symptoms are very apt to be atypical when the myocardium is so badly damaged before the onset of the infarction. Therefore, I believe that an ante-mortem diagnosis of cardiac infarction on top of chronic myocardial fibrosis and coronary sclerosis was the logical diagnosis in this case.

SUMMARY.

1. Coronary thrombosis or occlusion and cardiac infarction are pathological terms bearing the relation of cause and effect to each other.

2. Infarction of the myocardium is divisible into various stages pathologically: (a) Extravasation of blood, (b) Degeneration and necrosis of muscle, and (c) Replacement fibrosis or cicatrization.

3. The typical syndrome of coronary thrombosis is similar to that of angina pectoris, but more severe

and unrelieved by rest and nitrites.

4. In atypical cases, especially those in which the heart is already damaged by chronic coronary sclerosis and myofibrosis, pain may be a minor symptom,,or even entirely absent.

5. Many cases have marked abdominal symptoms and must be differentiated from acute surgical conditions of the abdomen.

6. Death may occur at any time during infarction from disturbance of heart function or from rupture of the heart.

7. The diagnostic features of coronary thrombosis are: (a) Substernal or epigastric pain unrelieved by rest or nitrites, except possibly temporarily in the early stage of thrombus formation, and often referred to one or both arms (usually the left);

(b) Profound shock with pallor, sweating, and agonized facies;

(c) Fall in blood pressure;

(d) Heart sound failure;

(e) Pyrexia and leucocytosis;

(f) Disturbances in the mechanism of the heart;

(g) Signs of decompensation quite frequently;

(h) Electrocardiographic changes;

(i) Rapid red cell sedimentation time; and

(j) Pericardial friction rub .

8. Three typical cases are reported (Cases I, II, and III) with the following findings:

(a) All were males of middle age or older, who had generalized arteriosclerosis, hypertension, and angina pectoris for several years preceding the infarction.

(b) Two died, Case III within 15 or 20 minutes after thrombosis, Case II at the beginning of the third week.

(c) Case I was apparently recovering when last seen, but was given a bad prognosis because of insufficient rest in bed and residual signs of decompensation.

(d) Pain was the outstanding symptom in each case, referred to both arms in Case I and localized to the chest and epigastrium in Cases II and III.

(e) The fatal cases both had marked abdominal symptoms and were thought by patient and family to be"acute indigestion".

(f) Case III was autopsied and infarction proven, but no ante mortem findings were secured because of immediate death.

(h) Fever was not constant in the other two cases, mouth temperature being normal throughout in Case II, and only slightly increased at times in Case I.

(i) Leucocytosis was present in Case I, bu was not determined in the others.

(j) Fall in blood pressure was very marked late in the course of the infarction in Case II but not on the first day after onset, and was not present in Case I as far as determined.

(k) Heart sound failure was present in both cases subjected to a thorough ante mortem examination.

(l) Electrocardiographic record was secured only in Case I and showed evidence of infarction.

9. Three other cases are reported in which generalized arteriosclerosis, advanced coronary sclerosis, and myocardial fibrosis were the main features; but in which coronary thrombosos could, and possibly did at some time or other, occur without the typical clinical syndrome of cardiac infarction. One of these cases had a very suggestive final picture of severe pain and collapse, but autopsy proved that no actual coronary occlusion had occurred, only morked sclerosis.

Claude T. Mason
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